Radboud Repository

Radboud University Nijmegen

PDF hosted at the Radboud Repository of the Radboud University Nijmegen

This full text is a publisher's version.

For additional information about this publication click this link.
http://hdl.handle.net/2066/29577

Please be advised that this information was generated on 2014-11-16 and may be subject to change.

Menno Hulswit

Peirce's Teleological Approach to Natural Classes[1]

> Every classification has reference to a tendency toward an end. If this tendency is the tendency which has determined the class characters of the objects, it is a natural classification. (*NEM*, IV, 65; 1902)[2]

Though Peirce's theory of natural classes is often mentioned in contemporary philosophy of science and metaphysics (Ian Hacking for example gives Peirce a prominent place in the tradition of natural kinds[3]), it has not as yet been studied thoroughly. Accordingly, the presentation of Peirce's theory is often only partially correct, and sometimes even misleading. Perhaps the main reason for the absence of a thorough study is that Peirce's theory of natural classes is intimately related to his theory of final causation[4]— a concept which in contemporary philosophy is avoided for being a mystifying idea which neither agrees with the methods nor with the results of modern science. In a previous paper[5] an attempt was made to show that this is a biased view, due to a number of false presuppositions, which were clearly recognized by Peirce a century ago. In this paper it will be shown that Peirce's theory of natural classes is intimately linked to his conception of final causation.

Peirce held the view that in each act of causation there is an efficient and a final component: final causes are general types that tend to realize themselves by (teleologically) determining processes of efficient causation. They are not future events, but general, physical possibilities. The efficient aspect of causation is that each event or

Transactions of the Charles S. Peirce Society
Summer, 1997, Vol. XXXIII, No. 3

fact is caused by a previous event or fact (the efficient cause); the teleological aspect is that each event or fact is part of a chain of events with a definite tendency. The tendency is the final cause of the process. This entails that each act of causation is mediated by a final cause.

Indeed, Peirce held that the condition for causes and effects to be mediated by final causes is that they belong to a natural class. Thus, Peirce's theory of causation requires an elucidation of his concept of natural class. Conversely, since Peirce defines natural classes in terms of final causation, his concept of natural class must be considered *within the perspective of his theory of final causation.*

There are now at least three reasons for considering Peirce's theory of natural classes: first, it has (as far as can be determined) never before been studied within its proper context of teleological causation. Secondly, Peirce's theory of natural kinds is thought by many to be relevant to contemporary discussions. Thirdly, if a Peircean critique of most of the contemporary views of teleology has any merit, and if it is true that there is a close link between the concepts of causation and natural class, then this critique may have serious consequences for contemporary debates on natural classes. An additional reason for discussing Peirce's theory of natural classes is that it provides a good ground for discussing his alleged pluralism, which is a hot topic in contemporary Peirce studies. Accordingly, *the first objective of this paper is to reconstruct Peirce's theory of natural classes. The second objective is to examine Peirce's view of the relationship between natural classes and causation, and to see whether it contains insights that might be relevant to contemporary debates on natural kinds and causation.*

1. NATURAL KINDS AND CAUSATION IN CONTEMPORARY PHILOSOPHY

That there is a close relationship between causation and natural kinds is not as strange as it may seem at first. In the contemporary philosophy of science and metaphysics it is widely believed that the concepts of causation, explanation, natural law, and natural kind are interrelated. For example, in an influential paper on natural kinds, W.V. Quine (1969, 132) emphasizes that the concept of causation

entails the concept of natural kind: "To say that one event caused another is to say that the two events are of *kinds* between which there is invariable succession." Twenty years later, D.M. Johnson (1990, 63) defines a natural kind as "a spatiotemporally unrestricted or repeatable category ineliminatively presupposed by at least one true and explanatory law of nature."

In their glossary to their anthology "The Philosophy of Science," the editors Richard Boyd, Philip Gasper, and J.D. Trout give a very general definition of natural kind, which, it may be assumed, is supposed to cover most current theories. A natural kind is:

> A type of property, process, state, event, or object studied by science, mentioned in scientific laws, and assumed to be *a causal feature of the world.* The primary instances of natural kinds are objects of scientific taxonomy, such as electrons in physics, zinc in chemistry, and species in biology. Natural kinds are contrasted with phenomena that are assigned no such systematic, organizing role, such as an event's occurring after I drop this pen, or an object's being located 34 miles west of the Liberty Bell. (1991, 778-9; italics mine)

According to this view, natural kinds, as opposed to other phenomena, play a systematic role in our explanations of the world; they are supposed to be something like the world's causal joints. The same idea is defended by J. Levinson (1991, 65), according to whom the objects belonging to a natural kind "occupy the same causal role in nature." As it is not at all obvious, however, what it involves to be 'a causal feature of the world' or to 'occupy the same causal role in nature,' it would seem clearly that the concept of natural kind presupposes an elucidation of the concept of causation.

Bigelow, *et al.* (1992, 373) stress that natural kinds are always associated with *essential properties.* "If something is of a natural kind, then there will be properties which this thing must have to be a thing of that kind, and which it could not cease to have without ceasing to be a thing of that kind." The idea that things belong to natural kinds

seems to involve a commitment to *essentialism*: what makes a thing a member of a particular natural kind is that it possesses a certain essential property (or a cluster of essential properties), a property both *necessary and sufficient* for a thing to belong to that kind. The essential property is supposed to provide an objective feature which determines to what kind a thing belongs, independently of any context of inquiry. It is also supposed to play an important *explanatory role* in regard to other properties and relations.

The main examples of natural classes used by philosophers are the chemical elements and biological species. Especially the chemical elements are often taken to be paradigm cases of natural kinds. Consider Saul Kripke's famous example of gold:[6] the fact that gold is defined by its atomic number, entails that a thing is made of gold precisely when it is composed of atoms that have atomic number 79. It is because "the essence of a natural kind must be *necessary*, *explanatory*, and *purely qualitative*" (Sober, 1995, 345; italics mine), that the atomic number 79 is said to provide the essence of the natural kind of gold. Whereas it is an accident that some lump of gold has a specific shape, it is supposed to be a *necessary* truth that golden things have atomic number 79. Moreover, the atomic number *explains* many properties of golden things. Finally, specifying the essence of gold does not involve a reference to shape, place or time; the atomic number supplies this general *qualitative specification* (Sober, 1995, 345).

The case of biological species is more complicated, for it is by no means clear that biological species have essences. The favored view is that species are *individuals*. According to this view species are said to be populations which have organisms as parts rather than as members (Hull, 1978). Organisms belong to the same species, not by virtue of their similarity, but because of their genealogical relatedness. Despite their common descent, they do not thereby form a natural kind (Sober, 1995, 346).

Apart from a certain agreement regarding chemical elements, philosophers tend heartily to disagree when it comes to giving clear examples of natural kinds. Thus Van Brakel (1992, 243-4) lists a number of different interpretations: while Putnam includes multiple scle-

rosis, gold, horses, and electricity, Kripke and Quine mention colors, Hacking suggests social kinds, and Churchland does not hesitate to include mass, length, duration, charge, color, energy and momentum. According to Van Brakel, this disagreement is not only due to different opinions regarding the distinction between natural kinds and artificial kinds, but more fundamentally different views regarding induction, prototypes, universals, scientific realism, meaning and reference.[7] Van Brakel might also have added the problems of causation, explanation and natural law.

Apparently there are a great many conflicting theories about natural kinds. To obtain some clarity in the problem, *a number of fundamental questions must be answered. Some of the most important are: (a) What are natural kinds?, (b) What argument is there for believing in their existence?, (c) What use has science for the notion of natural kind?, (d) What are the demarcation criteria by virtue of which one can decide to what natural kind an object belongs?, (e) Is there a uniquely correct grouping of objects into natural kinds, or are there countless legitimate, objectively grounded ways of classifying the objects of the world?, (f) What is the precise relationship between causation, natural laws, and natural kinds?*

But before pursuing these questions, we will first survey some recent interpretations of Peirce's theory of natural kinds with the object of obtaining a first impression of Peirce's view and of problems involved. The currant interpretations are rather meager and in many respects contradictory.

2. *SOME CONTEMPORARY INTERPRETATIONS OF PEIRCEAN NATURAL KINDS*

2.1 Susan Haack's Interpretation

A contemporary philosopher who stresses the importance of a detailed study of Peirce's concept of natural kind, is Susan Haack. According to Haack in her "Extreme Scholastic Realism: Its Relevance to Philosophy of Science Today" (1992), Peirce's 'extreme scholastic realism' entails that there are real laws of nature and real kinds, which are not dependent upon our characterization of the world. Haack

defends Peirce's 'scholastic realism' as a necessary presupposition of the whole scientific enterprise, but she realizes that "a full and detailed defense of this claim would require a better understanding of what makes a class natural" (Haack, 1992, 42). As Haack understands it, it is Peirce's view that without real laws and real kinds, no genuine science is possible. Without them there can be no explanation, nor can there be prediction or induction (1992, 28; 1993a, 134).

According to Haack, Peirce's realism entails that the particular facts and events we observe, are the expression of an underlying pattern of natural kinds and laws. While particular facts and events are concrete, the underlying pattern consists of so called *generals*. This pattern is real inasmuch as it is independent of how any individual inquirer thinks about it. As science — which is by its very nature co-operative — proceeds, this real pattern will eventually emerge: "Which generals are real is a matter which would only be finally settled in a hypothetical completed science" (1992, 29; also 1993b, 353). If science were to continue long enough, it would yield true classifications and true laws of nature, that is to say, classifications and laws "from which the local and idiosyncratic, the unreal, had been eliminated" (1992, 32).

Haack offers a number of different descriptions of Peircean natural kinds that might help us to obtain a preliminary understanding. Natural kinds are: (1) "clusters of similarities holding together in a lawful manner," (2) generals "that would figure in the laws," and (3) "the kinds of things in the world which really do behave in a lawlike way."[8]

As examples of Peircean natural kinds Haack mentions horses, men and stones. Since there are no laws of nature that are specific to stones, the suggestion is that Peirce has a very broad idea of law. Haack observes, almost casually, that genuine Peircean laws are basically *habits* (1992, 28). Thus, stones as well as fundamental particles are natural kinds because they are the kind of things in the world that behave in a habit-like manner. Moreover, the habitual aspect of natural kinds is illustrated by the fact that, for instance, stones that do not actually fall, are nevertheless capable of falling. For laws (habits) sustain *subjunctive conditionals*; they tell "not just what does happen when ..., but what would happen

if ..." (Haack, 1992, 28). We expect that if someone *would* for instance drop the stone he has in his hand, it *would* fall to the ground.

2.2 Christopher Hookway's Interpretation

Hookway's interpretation differs sharply from Haack's position. He interprets Peirce as holding that there are infinitely many, but equally legitimate ways of dividing the world into kinds:

> It is as if cognitive activity inevitably reads into reality a sort of articulated gesture, a system of classifications, which enables us to bring our experience under control, but which does not correspond to anything real. Indeed Peirce's picture of reality is close to this. He sees it as a continuous spread of reaction and feeling; where we draw the boundaries in thinking of it as containing individual objects, or how we classify the continuous range of possibilities which underlie general laws and characters is up to us. *Generality is real, but dividing things into classes reflects our interests and conventional decisions.* (Hookway, 1985, 251; italics mine)

According to this description, Peirce is presented as an "anti-realist" who rejects the possibility of giving an objectively correct system of classifications, which reflects the nature of natural classes (Hookway, 1985, 250). While Haack defended the view that our personal considerations do not interfere in the ultimate (Peircean) scientific classification and that there is but one legitimate way of dividing the world into (Peircean) kinds, Hookway insists that, according to Peirce, classifications are entirely subjective and that there are countless correct ways of classifying the objects of the world.

2.3 Sandra Rosenthal's Interpretation

A third interpretation is given by Sandra Rosenthal: dividing things into classes *partly* reflects our interests and conventional decisions, and *partly* the way things really are. Consequently, there are many, but not infinitely many, equally legitimate ways

of dividing the world into natural classes:

> Knowledge is abstractive and selective. A world, though concrete, is nonetheless selective in the sense that a world, as the concrete content denoted by a system of meanings, is a way in which the concreteness of reality can be delineated or "fixed." A system, once chosen, limits the alternatives possible within it, but *alternative systems may be possible*. (1994, 7-8; italics mine)

While our abstractive and selective process of knowledge imposes "cuts" upon the world, the decision regarding where these "cuts" occur is at least partially ours:

> As Peirce notes, "Truly natural classes may, and undoubtedly often do, merge into one another inextricably" (*CP* 1.209), and thus boundary lines must be imposed, although the classes are natural. The continuity is there; where the "cut" is imposed is, in part, our decision. (Rosenthal, 1994, 8)

Thus, whereas Rosenthal with Hookway grants that there is an arbitrary element in establishing boundary lines between natural classes, she agrees with Haack in insisting that there is an objective ground to our natural classifications. Yet Rosenthal fails to tell us what such arbitrariness or convention entails. Does the absence of clear boundary lines entail that natural classes are not clearly defined? Or does it only mean that there are no clear demarcation criteria by virtue of which it can always be decided to which natural class an object belongs.

The three foregoing interpretations raise a fundamental question concerning the nature of Peirce's genuine or assumed *pluralism*: what, according to Peirce, is the (epistemological and ontological) origin of our dividing the world into classes? Perhaps the best way of introducing Peirce's own views is to consider his critique of John Stuart Mill's definition of natural kind.

3. PEIRCE VERSUS MILL

3.1 Mill's theory of natural kinds

According to Mill, every thing in the world belongs to some natural class or real kind. Mill made a distinction between natural classes and non-natural or artificial classes (Mill did not use the latter term). The main difference is that the things that compose a natural class have innumerous properties in common, whereas the things that belong to an artificial class resemble one another in but a few respects.

More precisely: a "real kind" is defined as a class "which is distinguished from all other classes by an indeterminate multitude of properties not derivable from one another..." (Mill, 1874, 99). The members of a natural or real class share innumerable properties that are not derivable from its defining character "by some law of causation." Plants and animals, and sulphur and phosphor are examples of real kinds (Mill, 1874, 97).

In contrast, the members of an artificial class share only a few properties, which "follow, as consequences, under laws of nature, from a small number of primary [characters] which can be precisely determined, and which, as the phrase is, *account for* all the rest" (Mill, 1874, 98-99). The class of white things is an example of an artificial class:

> White things are not distinguished by any common properties, except whiteness: or if they are, it is only by such as are in some way connected with whiteness. But a hundred generations have not exhausted the common properties of animals or plants, of sulphur or phosphorus; nor do we suppose them to be exhaustible, but proceed to new observations and experiments, in the full confidence of discovering new properties which were by no means implied in those we previously knew. (Mill, 1874, 97)

Similarly, the class of flat-nosed animals is an artificial class, because in addition to their flat noses, flat-nosed animals do not have any common properties other than those which are common to all animals (1874, 99).

Mill seems to have been the first philosopher to seriously consider social kinds,[9] such as those of Christians, Englishmen, and Mathematicians. He thought them to be artificial kinds, however, because there is no innumerable set of properties "common and peculiar" to Christians or Englishmen or Mathematicians; the limited number of properties shared by the members of the class are logically or causally determined by their definitions: "A Christian, for example, differs from other human beings; but he differs only in the attribute which the word expresses, namely belief in Christianity, and whatever else that implies, either as involved in the fact itself, or connected with it through some law of cause and effect" (Mill, 1874, 98).

3.2 Natural Kinds and the Uniformity of Nature; Peirce's Earliest Discussion of Natural Kinds

The problem of natural kinds first appears in Peirce's work in "The Fourth Lowell Lecture" (1866). The main objective of this lecture was a critical discussion of Mill's treatment of induction. In the course of the lecture Peirce raised two issues that are directly relevant for our understanding of his mature theory of natural kinds. The first issue concerns the relationship between natural classes and the uniformity of nature; the second issue pertains to the problem of defining a natural class.

Mill's justification of the use of induction was based on his belief in the uniformity of nature. Peirce criticized this view by pointing out that it begs the question: the justification of the belief in the uniformity of nature is based on the use of induction (*W* 1, 414; 1866). Whereas Peirce agreed with Mill that "everything there is belongs to some real kind" (*W* 1, 416), he questioned Mill's idea that the uniformity of nature consists in the existence of natural classes. First he pointed out that, while uniform relations are one type of relations in nature, there are many more entirely irregular relations:

> Take any pear. It is sweet and all pears are sweet. There is a uniformity. But it is *mine;* and all pears are not mine. It is next to a bunch of grapes, and all pears are not next to a

> bunch of grapes. It is ripe and not all pears are ripe. [...] And so I might go on indefinitely. Indeed when it is remembered that everything in the world is related to every other in countless ways; it is plain that there is no end to the excess of accidental relations over those which present any regularity. (*W* 1, 417).

Thus, the number of irregularities in individual objects and in natural classes greatly exceeds the number of regularities. Horses, for example, have all kinds of characters in common, like swiftness, strength, and timidness; they all have backbones and long heads; they are all herbivorous, etc. But, not all animals with backbones are herbivorous, and not all strong things are swift. "So that even in this respect nature is not very uniform" (*W* 1, 418).

Secondly, the statement that there are *exact* uniformities is not warranted by experience:

> Every student of physics knows that a law which is exactly conformed to in nature without interference from other laws, is almost if not quite unknown. Every law that is discovered therefore is found after a few years not to be exact. (*W* 1, 420)

Moreover, since there are exceptions to almost any rule (*W* 1, 419), it is highly improbable that there are uniformities in nature that are exact or without exception.[10]

Peirce concluded from these observations that *the objects that belong to the same natural class, need not have all the characters that seem to belong to the class*: "it must be admitted that there are exceptions to almost every rule. Thus many of the characters which seem to belong to a class universally only belong to a part of it" (*W* 1, 419). Peirce gave the example of a man with two heads. Though having just one head is a character that belongs to the class of Man universally, it is not impossible that one day a man would be born with two heads. Whereas he would be an exception to the general rule, he would still belong to the natural class of Man. Therefore, if

we use Mill's definition of uniformity of nature — "the universe is so constituted, that whatever is true in one case, is true in all cases of a certain description" — then "natural classes cannot constitute a uniformity in nature" (*W* 1, 420).

The second issue that is relevant to our understanding of the mature Peirce concerns his *definition of natural class*. According to Peirce, natural classes have at least one characteristic in common apart from their defining character. *A natural class "has other properties than those which are implied in its definition"* (italics mine), for to define something is just to state the meaning of a word. If we define Man as a rational animal, then the expression "Man is rational" is simply an analytic statement. But each class has other properties than those implied in its definition; what makes a class natural is that there is at least one other universal character over and above the characters that compose its definition:

> Suppose this black board were dotted all over with chalk; and let these dots represent the individuals in the world. Then let us draw a circle around those which have any common character. Let this circle for example include all the animals and this other all the rational beings. Then what they both include would be rational animals. And this will be represented as a natural class if it be entirely or nearly enclosed by another circle. That will be all that is required to make it a natural class for then it will have a universal character besides the rational and animal which compose its definition. (*W* 1, 419; 1866)

One year later, Peirce came to the following definition of natural class:

> ... a natural class is one which can be so defined that something can be predicated of it which cannot be predicated of the genera included in its definition. (*W* 2, 443; 1867)

The other character is, according to Peirce, precisely what makes the difference between a logical definition and a scientific one. Taxonomists

cannot do with just a logical definition; they need some reference to empirical facts. Thus, Peirce seemed to suggest that, though the elements of natural classes have a number of empirical properties in common (*W* 1, 418), the taxonomist is free to choose those he considers to be relevant. Any empirical fact which belongs to all (or nearly all) the members of the class will do, not just the ones that are specific to the members of the class. Thus, if man be defined as a rational animal, 'man' is the natural class, 'rationality' is the defining character, and 'a humanlike set of teeth' could serve as the empirical character.

To summarize: according to the early Peirce, (1) everything in the world belongs to some natural class or real kind; (2) natural classes do not constitute uniformities; (3) *a natural class is characterized by (a) a defining character and the characters it implies, and (b) an empirical character which belongs to all or nearly all the members of the class.*

3.3 Peirce's Baldwin Definition of Kind

Having obtained some insight into Peirce's earliest view of natural kinds, we will now consider some of Peirce's later texts, especially his Baldwin definition of "Kind" (1901). In this latter text, Peirce gave, in just a few words, a devastating critique of Mill's theory of natural kinds: first, it is simply not true that artificial kinds like white things have only a few properties in common. When Mill talked of "properties," he must have had in mind, mainly, characters that are interesting to us. For it is obvious that all white things have innumerable common properties. Secondly, Peirce rejected Mill's idea that a class of elements whose common properties are caused by a few primary properties cannot be a natural kind. Indeed, it is precisely the goal of the man of science to explain the multitude of properties of a kind in terms of a small amount of underlying properties (*CP* 6.384, 1901).

In other manuscripts,[11] Peirce offered one simple example to disprove Mill's definition: the class *cow* is a natural class, while *red cow* is not. The class of red cows has all the features of the class of cows, and moreover, the feature of redness. If Mill would have admitted that the class of cows is a natural class, he also must have admitted that the

class of red cows is. For if it is true that cows belong to a natural class because they have a large or even apparently inexhaustible number of properties in common (which are not in any way dependent on its defining character), then the same must hold for red cows, because they even share one more common characteristic. Yet such a class is not a "real kind" (*MS* 421; 1893-5). Evidently Peirce presupposed that Mill would have accepted the common sense opinion that red cows do not form a natural class.

After thus having criticized Mill, Peirce gave the following *definition of natural class* (or real kind):[12]

> Any class which, in addition to its defining character, has another that is of permanent interest and is common and peculiar to its members, is destined to be conserved in that ultimate conception of the universe at which we aim, and is accordingly to be called 'real.' (*CP* 6.384; 1901)

Compared to his definition of 1867, Peirce makes explicit the idea that a natural class must have, over and above its defining character, another character which must not only be of permanent interest and common, but also *peculiar* to its members.

3.4 The PRE-character

Consider the case of 'man.' If 'man' is a natural class, the elements of that class must share a defining character, for example rationality. But human beings also share other properties. For instance, they all have a 'humanlike set of teeth.' But clearly this property is not directly related to their humanity. The character needed must somehow be relevant to what makes us distinctly human. Such character might for instance be the character of 'having a brain with a certain complex cortical structure.' Such character meets the requirements spelled out by Peirce in his preceding quote: it is not the defining character, it is of permanent interest, and it is common and peculiar to the members of the class. Because this character is genuinely empirical in nature, I shall henceforth refer to the defining character

as the *D-character*, and to the other character as the *PRE-character* (permanently relevant empirical character). The main difference is that while the D-character is a general principle (or 'Third'), the PRE-character is an essential quality (or 'First') embodied in an existing thing (or 'Second'). The most salient feature of a PRE-character is the requirement that it be permanently relevant, and thus permanently *important.*

In 1867 Peirce had given a definition of '*an important character*' which he still held to be correct in 1902.[13] According to his explanation in his 1902 paper "On Classification," a taxonomer considers a character to be important because it involves certain others, be it only "a particular likelihood to taking certain forms." Hence, "*importance* consists in a character's universally carrying with it certain others, be those others no more than tendencies" (*NEM* IV, 65; 1902). In the text of 1902, however, Peirce claimed that this 1867-definition needed a fundamental correction: "an important character must not only entrain others, but it must entrain another which has relation to the purpose in view" (NEM IV, 65). This entails that *the PRE-character universally carries with it certain other characters, though these may be only tendencies. Moreover, among those other characters there is at least one that is closely related to the D-character,* which, as will be shown in section five, is precisely what Peirce meant by "the purpose in view."

Thus, human beings, defined as rational animals, do form a natural class. The PRE-character of 'having a brain with a certain complex structure' "entrains," among other things, the tendency to form complex thoughts, which is a necessary condition for being rational. Thus, 'having a brain with a certain complex structure' is a good example of a close relationship between the PRE-character and the D-character.

Peirce's considerations about 'importance' allow us to modify his Baldwin definition as follows: a natural class is *any class that is characterized by a D-character and a PRE-character. The PRE-character universally carries with it certain tendencies, of which there is at least one that is closely related to the D-character.*

Given this definition, a number of problems arise. Of these, the

first one to be examined concerns the distinction between 'kinds' and 'classes,' which Peirce made near the end of his career (1908).

4. KINDS AND CLASSES

A kind is an entity that corresponds to a set, the elements of which do not exist; a class is an entity corresponding to a set of which at least one element does exist. Thus, Peirce pointed out for instance that, while in his time, black tulips were non-existent, nevertheless some people (for instance, gardeners) may very well have thought of the possibility of growing black tulips. While the kind 'black tulip' was real, there was no natural class of existing black tulips. For the 'existence' of a natural class requires the existence of at least one specimen of that kind:

> For the class is that *ens rationis* whose existence consists in the actualization of a definite kind. The actualization in an existing singular is one requisite to a class, being requisite to its *existence*: the character which it is required that every member of the class should have, is a second requisite to the class, being requisite to its *entity*. The two together make up its ousia, its rational *essence*. (*MS* 200/00172; 1908)[14]

This is an interesting definition for a number of reasons. The first thing that draws attention is that a class is called an *ens rationis* or "being of reason." Peirce applied this term, borrowed from Duns Scotus (and other scholastics), to entities that owe their reality to an operation of the intellect which Peirce called 'hypostatic abstraction.' Contrary to a real being or *ens in re extra animam*, such as a concrete, individual horse, an *ens rationis* is a 'thing' that depends for its existence upon reason or thought. Whereas real beings exist independently of thought, beings of reason depend on thought. But there are two kinds of *entia rationis*: those with a foundation in reality and those without foundation. Examples of the former are genera and species (for instance, animal and horse); examples of the latter are mythical figures.

Thus, according to Duns Scotus, some universals exist only by virtue of the operation of the intellect, but cannot in any sense be said to be mere 'figments' of the mind. We can form universal concepts only because there is an objective correlate of them in the objects themselves: the "common nature." *Horseness*, for example, is the common nature of all the things called horses. But *horseness* is neither a universal nor a particular. Horseness is simply horseness. Universals are concepts formed by the mind, but there is an objective basis to them in the "common nature" of the concrete, existing things.

Peirce had borrowed Duns Scotus's view to the extent that sometimes our abstractions reflect objectively real general principles: "that wonderful operation of hypostatic abstraction by which we seem to create *entia rationis* that are, nevertheless, sometimes real..." (*CP* 4.549; 1906). He also had borrowed Duns Scotus's idea that real generals have the reality of *possibility*, not of actuality, albeit with a different twist.[15] Peircean real generals are not common natures or forms, but final causes or laws.

That generals are possibles entails that, though they may be real, they do not exist. It may be noted that Peirce was somewhat careless when he spoke of the *existence* of natural classes, for classes cannot strictly be said to exist. The *members* of a class exist, but the class itself does not. Classes are *entia rationis*, which are generals, and generals are real but do not exist; they are possibilities. Only individual things exist, that is, only things which occupy a definite space during a certain time. Individuals can be pointed at; generals cannot.

We now know that *a class must meet at least two criteria: it must have at least one existing member, and each member of the class must have both a defining or D-character and an indefinite number of D-related class characters.*[16] *A kind differs from a class on two counts: it does not contain an existing member, and therefore it has only a D-character which constitutes its essence.*

Peirce makes a distinction between the epistemological essence and the metaphysical essence of a kind:

> The *essence* of anything is that thought which renders the thing possible. The *epistemological essence* is that thought which renders it possible to conceive of the things. The *metaphysical essence* is that intellectual structure which renders the being of the thing possible. (*MS* 200/00145; 1908)[17]

In natural classifications, the epistemological essence coincides with the metaphysical essence. According to Peirce, it is usually quite easy to determine the metaphysical essence of an artefact. The metaphysical essence of a lamp, for example, is that it can give light. And that is the purpose which brings lamps about. And the metaphysical essence of a stove is "that it is intended to diffuse warmth" (*CP* 6.336; circa 1909). But the question regarding the metaphysical essence of a natural object is much tougher.

One might wonder whether the distinction between metaphysical essence and epistemological essence makes any sense from a pragmatic perspective. Does it not presuppose a bifurcation between the realm of knowledge and the realm of being? And doesn't the idea of 'metaphysical essence' presuppose what Putnam has called "a God's eye point of view"? We have to admit that Peirce's terminology is confusing, for it suggests that there is an objective reality independent of our knowing processes. But this is not what Peirce had in mind. There is no metaphysical essence independent of our knowing processes; the metaphysical essence is independent of how you and I or anyone else at a specific moment characterizes the world. In the long run, however, the classifications of the scientific society will reflect the metaphysical essence of things. Much of the confusion arises from the fact that, though Peirce tries to break with traditional ways of conceiving the question of universals, essences, or kinds, he does not break with traditional language.

Another possible objection is related to the fact that the essence of anything is by nature immutable. But, contrary to Platonic or Aristotelian essences, and to Scotistic "common natures," which are all immutable, static forms, Peircean essences are of the nature of habit; and habits are, at least in principle, subject to evolution. Consequently, one

of the most persistent objections against natural classes, namely that they presuppose an immutable essence, does not hold for Peirce's position.

Yet another difficulty regards the intellectual structure of essences. Peirce, however, did not restrict 'idea' or 'thought' to something that a person has in mind, or to a psychical act of thinking: "by an idea [...] I mean a principle such as may be set before the mind in thought" (*MS* 1344, 11; 1902). Thus, the statistical distribution of a large number of things, say the molecules of a gas, expresses a statistical law which is the 'idea' of the distribution (*MS* 1344, 11; *NEM* IV, 65-66). Moreover, ideas are not only (a) general principles; they are also (b) in a sense purposive or quasi-purposive (end directed). Thus, the statistical law is a general idea, which is the final cause explaining the tendency toward the end state of the gas. *Ideas, therefore, have a certain inherent tendency to realize themselves.* An idea without efficacy cannot be an idea at all:

> Imagine such an idea if you can! If it was communicated to you *viva voce* from another person, it must have had efficiency enough to get the particles of air vibrating. If you read it in a newspaper, it has set a monstrous printing press in motion. If you thought it out yourself, it had caused something to happen in your brain. And again, how do you know that you did have the idea when this discussion began a few lines above, unless it had efficiency to make some record on the brain? (*CP* 1.231; 1902)

We have seen so far that *the essence of a natural class is of the nature of an idea, and* that *ideas are, basically, final causes.* The defining idea of a set of objects is its epistemological essence. In natural classes, however, the defining idea or epistemological essence reflects the metaphysical essence. Because the defining idea of a natural class is a final cause, it seems appropriate to further explore the purposive nature of ideas or essences.

5. CLASSIFICATION ACCORDING TO FINAL CAUSES

In his note "On Classification" of his Carnegie Application (1902),[18] Peirce mentioned that he had been a student of Agassiz (in 1861), and that his study over the years had convinced him that Agassiz' system of classification was basically correct. Peirce formulated Agassiz's central insight as follows: *"every classification whatsoever, be it merely arranging words in alphabetical order, has reference to some purpose, or some tendency to an end"* (*NEM*, IV, 65; 1902; italics mine). Thus, classifications are teleological instruments, or a way of handling things for some particular purpose. Now, arranging words in alphabetical order is an example in which it is just *our* purpose that determines the classification. That is why the classification is artificial. In *natural* classifications, however, it is not our purpose but the purpose or quasi-purpose of the class itself that is at stake:

> Every unitary classification has a leading idea or purpose, and is a natural classification in so far as that same purpose is determinative in the production of the objects classified. (*NEM*, IV, 15; 1902)

Similarly,

> Every classification has reference to a tendency toward an end. If this tendency is the tendency which has determined the class characters of the objects, it is a natural classification. (*NEM*, IV, 65; 1902)

Thus, the defining idea of a natural class teleologically determines the class characters of the objects belonging to the class. To clearly distinguish them from the PRE-character (permanently relevant empirical character), we will call the class characters from now on *TDE-characters* (teleologically determined empirical characters). Though Peirce sometimes used the term "essential characters" (for example in *CP* 1.204), for reasons yet to be explained, his term "class characters" is more appropriate.

In order to precisely understand the relationship between defining character and TDE-characters, we must consider what is perhaps Peirce's most important text on natural classes, "A Detailed Classification of the Sciences" (*CP* 1.203-283; 1902), where he worked out his view that ideas may be said to be teleologically causal. Properly speaking, the text deals with the problem of finding a classification scheme in which all the sciences find their hierarchical place. But since his anti-nominalistic stance implied that such a scheme is based on natural or real classes, Peirce thought it necessary first to explain what he meant by a natural class. In his attempt to give an exact description of a natural class, he concluded that the final cause is its defining characteristic. Accordingly, a natural or real class is defined as *a class "of which all the members owe their existence to a common final cause"* (*CP* 1.204), or as *"a class the existence of whose members is due to a common and peculiar final cause"* (*CP* 1.211). The final cause is described in this context as "a common cause by virtue of which those things that have the essential characters of the class are enabled to exist" (*CP* 1.204). Thus, the defining idea must clearly be understood as causally active in the teleological sense. For instance when Peirce wrote:

> [e]very class has its definition, which is an idea; but it is not every class where the *existence*, that is, the occurrence in the universe of its members is due to the active causality of the defining idea of the class. That circumstance makes the epithet *natural* particularly appropriate to the class... (*CP* 1.214; 1902),

the expression 'active causality' must be taken in this teleological sense. In view of this, we must again return to the general characteristics of Peirce's conception of final causation.

According to Peirce, final causes are general types that tend to realize themselves by determining processes of mechanical causation. They are not future events, but general (physical) possibilities. The symptoms of final causation are that the end state of a process can be reached in different ways, and that the process is irreversible. Final causes are basically habits: they ('habitually') direct processes toward

an end state. Like human habits, habits of nature (laws of nature) are final causes because they display tendencies toward an end state. Final causes stand to laws of nature as genus to species. Moreover, habits are not static entities, for they may evolve in the course of time. Peirce called the possible evolution of final causes "developmental teleology."[19]

In view of this, what does it mean to say that a natural class owes its existence to a common defining idea or final cause?

> Do I mean that the idea calls new matter into existence? Certainly not. That would be pure intellectualism, which denies that blind force is an element of experience distinct from rationality, or logical force. [...] What I mean by the idea's conferring existence upon the individual members of the class is that it confers upon them the power of working out results in this world, that it confers upon them, that is to say, organic existence, or, in a word, life. (*CP* 1.220; 1902)

Ideas cannot call new matter into existence; they can only work if there is matter to work upon. The action of ideas is typical of final causation; the action of matter is typical of efficient causation. Blind force (efficient causation) and rationality (final causation) are two undeniable elements of our experience; one requires the other. But all this does not as yet explain that "the idea [confers] existence upon the individual members of the class," and that it gives them "organic existence" or "life." The reason must be that, if matter were not governed by ideas or final causes, there would not be any regularity in its behavior, which means that it would not even *exist:*

> ... if [matter] were to be deprived of the governance of ideas, and thus were to have no regularity in its action, [...] throughout no fraction of a second could it steadily act in any general way. For matter would thus not only not actually exist, but it would not even have potential existence, since potentiality is an affair of ideas. It would be just downright nothing. (*CP* 1.218; 1902)

Two examples may illustrate Peirce's intention. The first is taken from the realm of social phenomena: the natural class of socialists. A member of the community of socialists can only be a socialist by virtue of the idea of socialism. In Peirce's view, it is the idea of socialism that creates the socialist, not the other way round. Ideas are not just creations of a particular mind, but on the contrary, they have a capacity, a power, to create or to find their vehicles: "it is the idea which will create its defenders, and render them powerful" (*CP* 1.217). Of course, the idea of socialism does not create the *person* who is the socialist. But, given an existent person, the idea of socialism may turn him into a socialist. The idea of socialism confers existence upon the individual members of the natural class of socialists. It gives them "organic existence" or "life" *as socialists*, that is to say, it makes them behave, at least to a certain extent, as socialists are supposed to behave. To exist *as a socialist* requires a certain amount of regularity in one's behavior; it requires that one's behavior be directed by the idea of socialism.

The second example is related to what might be called Peirce's (metaphysical) holism. Final causation is seen as that general principle in virtue of which a whole is more than the sum of its parts. The final cause is the intellectual structure or thought that ties the parts together, and gives them "organic existence" or "life." In Peirce's words:

> Efficient causation is that kind of causation whereby the parts compose the whole; final causation is that kind of causation whereby the whole calls out its parts. (*CP* 1.220; 1902)

Thus, it is the final cause which confers "organic existence" or "life" upon the individual members of a natural class. To illustrate this idea, Peirce gave the example of a dissected corpse. No one would consider a man's organs lying separately on a stretcher as a human being. The dissection might give some insight into what parts are required to make the human body work, that is, it would at most display efficient causation. But it cannot explain *why* a human body works: "The final causation, which is what characterizes the *definitum*, it leaves out of account" (*CP* 1.220). The final cause is that principle whereby

a person is something more than just a body; it gives the body "organic existence" or "life."

Peirce had a simple and convincing answer to anyone who would object, and who would insist that it is only matter that is essential for the existence of an individual person: whereas the matter we are made of continually changes, our form remains the same. The existence of an individual man is something altogether different from the matter he happens to be composed of, and "which is incessantly passing in and out."[20] That which gives continuity to his existence is not the matter but the form, that is, his defining idea. This defining idea or final cause is what traditionally has been called the soul of man.

There is every indication that Peirce's conception of the defining idea slowly evolved as he gradually became more committed to a scholastic realism.[21] Whereas in 1866 the defining idea had a predominantly epistemological status, from 1902 onwards its status was first and foremost *ontological*. While in 1866 Peirce had defined a natural class as a "class that has other properties than those which are implied in its definition and these other characters would make it a natural class" (*W* 1, 418; 1866), in 1902, the defining idea is no longer a character which *logically* implies certain other characters. Instead, it is a final *cause* to which the members of the class owe their existence: the existence of the objects of the class "is due to the *active causality* of the defining idea of the class" (*CP* 1.214; italics mine). Whereas in 1866 the defining idea had supplied the epistemological essence of the class, that is to say, "that thought which renders it possible to conceive of things," in 1902 it displayed the metaphysical essence or "that intellectual structure which renders the being of the thing possible."

Whereas until 1901 (in his Baldwin definition) Peirce had emphasized the *permanently relevant empirical character* (PRE-character), from 1902 onwards he had replaced it by an indefinite number of *teleologically determined empirical characters* (TDE-characters), which were subservient to the *defining idea* or D-character. The main difference between PRE-characters and TDE-characters is that, contrary to PRE-characters which are *essential* qualities but not teleologically determined by the D-character, the TDE-characters are 'non-

essential' qualities (in a sense yet to be explained) which are teleologically determined by the D-character.

The question whether knowledge of the common final cause is sufficient to determine the class (or classes) to which an object belongs, or whether we need other demarcation criteria, requires examination.

6. CRITERIA OF DEMARCATION

Because natural classes must be understood in terms of final causes, it is necessary first to consider some further characteristics of final causes before the question of demarcation criteria can be addressed.

Final causes are general. This generality involves both *vagueness* and *longitude*. Final causes are *general* because: (1) they are not spatio-temporal; (2) they determine only *some* but not all qualities of a class of objects (or of a process). For example, the idea of building a house only determines that the end product will be a house, but not the specific form of the house. This lack of specificity is also called the *vagueness* of the final cause. Finally (3), final causes are general because they are not exhausted by any finite number of instantiations.

Moreover, final causes have a certain *longitude*. "By this I mean that while a certain ideal end state of things might most perfectly satisfy a desire, yet a situation somewhat different from that will be far better than nothing; and in general, when a state is not too far from the ideal state, the nearer it approaches that state the better" (*CP* 1.207; 1902). If, for some reason, we do not succeed in realizing our plan to write a book on natural kinds, the second best thing would be to write some articles on the subject. Though there was a definite tendency toward an end state — a book on natural kinds —, external or internal elements kept our purpose from being fully realized. But a partial realization is much better than no realization at all.

A third element, next to their longitude and vagueness, is important to the determining cause of a natural class: although a final cause is in itself rather general and simple, it necessarily tends to a greater definiteness and complexity in the course of its realization (*MS* 1343, p.15; 1902). Such process usually involves conditions that are specific to every step, as well as 'decisions' regarding the further realiza-

tion of the general purpose. In the course of building a house, all kinds of decisions must be made about shape, size, material, etc., and each of these functions as a subsidiary purpose.

As a result of (a) the vagueness and (b) the longitude of final causes, and as a result of (c) the action of subsidiary final causes, *the class characters of the objects of a natural class (that is, the qualities determined by its final cause) cluster around certain average values.* Peirce illustrates this by an example borrowed from human experience: if we are to produce artificial light as economically as we can, we must consider all kinds of additional subsidiary purposes:

> ... the situation of things most satisfactory to one desire is almost never the situation most satisfactory to another. A brighter lamp than that I use would perhaps be more agreeable to my eyes; but it would be less so to my pocket, to my lungs, and to my sense of heat. Accordingly, a compromise is struck; and since all desires are somewhat vague, the result is that the objects actually will cluster about certain middling qualities, some being removed this way, some that way, and at greater and greater removes fewer and fewer objects will be so determined. *Thus, clustering distributions will characterize purposive classes.* (*CP* 1.207; 1902; italics mine)

This consideration is relevant to the issue of demarcation criteria. Peirce illustrated this with an example taken from archeology:

> ... Prof. Petrie found in the town of Naucratis some hundred and eighty standard weights. The calculus of probabilities applied to their weight-values proves that they were intended to conform to five different quasi-prototypes; but many of the weights, owing to the imperfection of their manufacture, have intermediate values, so that, as far as their governing intended character goes, it would be impossible to say to which standard any one such intermediate weight was intended to conform. (*MS* 1343, p.14; also 1.209-10; both 1902)

This example reveals that *closely related classes are not, in general, separated by sharp lines of demarcation.* Some forms may just as well belong to one natural class as to another. In such cases, further investigation will usually show that there are other, more or less accidental characters, which may help in directing the forms to their true classes. Such characters, which are not specific to the class, may help us in ascertaining whether a given individual belongs to one class rather than the other: "unless we have some supplementary information we cannot tell which ones had one purpose and which the other" (*CP* 1.208). In the case of Petrie's example, further information might concern the shapes or the material of the stones, or some other "inessential" character (*MS* 1343, p.13-14).

The example of the weights also reveals that, though natural classes are characterized by a defining idea which makes up their metaphysical essence, *there are no essential qualities that are both necessary and sufficient for belonging to a specific natural class:*

> [We may want to] enumerate characters which are absolutely decisive as to whether a given individual does or does not belong to the class. But it may be, as our [example of the weights] shows, that this is altogether out of question; and the fact that two classes merge is no proof that they are not truly distinct classes. (*CP* 1.224; 1902)

Though there are no essential qualities by virtue of which it can unambiguously be ascertained to which natural class the weights with intermediate values belong, they nevertheless were intended to conform to one definite prototype. Each of these weights therefore belongs to one specific natural class. Apparently, in 1902 Peirce had distanced himself from his Baldwin definition (1901), according to which each member of a natural class was characterized by at least one essential quality: its permanently relevant empirical or PRE-character. *Thus, things belong to the same natural class, not because of some essential qualities (which are Firsts according Peirce's categorial system), but because of a metaphysical essence which to an idea or final cause (which is a Third).*

Moreover: in the last quote, Peirce seems to reintroduce his 1866-idea that the objects that belong to the same natural class, need not have all the qualities that seem to belong to the class: "it must be admitted that there are exceptions to almost every rule. Thus many of the characters which seem to belong to a class universally only belong to a part of it" (*W* 1, 419; see section 3.1). *Class qualities therefore are not essential qualities.*

7. RECAPITULATION: DEFINITION OF PEIRCEAN NATURAL CLASSES

Because the developments in Peirce's conception of natural classes are relatively complex, it may be good to summarize the results obtained so far. This summary will be followed by an attempt to formulate a definition of Peircean natural kinds that displays Peirce's mature position as fully as possible.

In 1866, Peircean natural classes were characterized by (a) a defining character, (b) characters that are logically implied by its definition, and (c) an empirical character (section 3.1).

According to Peirce's Baldwin definition of "Kind" (1901), natural classes were characterized by a defining character (D-character) in combination with one empirical character (PRE-character). Both characters were thought to be "of permanent interest" and were considered to be "common and peculiar" to the members of the class (3.2).

We proposed a reformulation of Peirce's Baldwin definition of "Kind," based on Peirce's note "On Classification" of his Carnegie Application (1902). According to this reconstruction, a Peircean natural class is any class that is characterized by a D-character and a PRE-character, both of which are common and peculiar to the members of the class. The PRE-character universally carries with it certain tendencies of which there is at least one that is closely related to the D-character (3.3).

In 1908 Peirce made a distinction between natural classes and kinds. Whereas a kind is an entity corresponding to a set the elements of which do not exist, a class is an entity corresponding to a set of which at least one element exists. A class must meet at least two criteria: it must have at least one existing member, and each member of

the class must have both a D-character and at least one teleologically determined empirical character (TDE-character). A kind differs from a class on two counts: it does not contain an existing member, and therefore it has only a D-character which constitutes its essence (4).

Peirce adopted Duns Scotus's view of classes as *entia rationis,* owing their reality to an operation of the intellect. *Natural* classes are abstractions corresponding to objectively real general principles. They are, however, not pure abstractions (or 'Firsts'), but generals ('Thirds') embodied in concrete extisting things ('Seconds'). Because these real generals are *possibilities,* not actualities, natural classes cannot strictly be said to exist, but are nevertheless real (4).

In 1902 Peirce related natural classes to their final causes. Accordingly, he defined a natural class as "a class the existence of whose members is due to a common and peculiar final cause" (*CP* 1.204), by virtue of which the members of the class behave in a regular way which is characteristic for that particular class (5).

Peirce's relating natural classes to final causation marked *an important shift in the evolution of his conception of natural classes.* Whereas in its original definition (1866), the function of the defining idea of a natural class was predominantly epistemological, in his later works he defined natural classes in terms of final causation, and thus the defining character came to display the metaphysical essence of the class (5). Thus, whereas for the early Peirce (1866), the relationship between defining idea and essential qualities was a *logical* one,[22] to the later Peirce (1902), the determination of the class or TDE-characters by the defining idea was (teleologically) *causal.*

This shift toward a causal relationship between the defining idea and its class characters had the advantage that Peirce no longer needed to refer to 'important empirical characters' (PRE-characters), since *every* class or TDE-character is closely related to the defining idea because it is teleologically caused by it. Moreover, TDE-characters are not essential qualities because they need to be neither common nor specific to the members of the class.

As a result of (a) the vagueness and (b) the longitude of final causes, and (c) the action of subsidiary final causes, the class qualities of

the objects of a natural class (the qualities determined by its final cause) cluster around certain average values. Accordingly, closely related classes are not, in general, separated by sharp lines of demarcation (6).

The example of the weights revealed that things do not belong to the same natural class because of some common essential qualities (Firstness), but on account of a similarity in behavior; they conform to the same final cause or law. The locus of universality is final causation, habit, or law (Thirdness) (6).

On the basis of this reconstruction I propose to give the following characterization of Peircean natural classes: *Things belong to the same natural kind, not because of certain essential qualities (Firsts), but on account of a metaphysical essence which is a final cause (or Third). Thus, Peircean natural classes are characterized by (a) a defining character, which is a final cause and (b) a number of class characters or teleologically determined empirical characters (TDE-characters); moreover, (c) the TDE-characters of the objects of a natural class cluster around certain average values; (d) the TDE-characters are not essential characters because they are neither necessary nor sufficient conditions for making something to be a member of the class; (e) there are no clear boundary lines between closely related natural classes; (f) natural classes, though very real, are not existing entities; their reality is of the nature of possibility, not of actuality.*

8. WHY BELIEVE IN NATURAL CLASSES?

It is a well known fact that Peirce was greatly interested in medieval logic, especially in the works of the nominalist William of Ockham and the realist Duns Scotus. He thought that nominalism was the greatest source of the mistakes of modern philosophy (*CP* 6.348, c. 1909; *CP* 5.61, 1903). On the other hand, he thought the philosophy of Duns Scotus offered a good basis for a philosophy "which is best to harmonize with physical science" (*CP* 1.6, c. 1897). Whereas Ockham held that only individuals exist in the real world and that universals are mere names, Scotus insisted that the real world contains real universals or generals.

Peirce thought the question regarding the reality of universals

not only of great technical philosophical value, but also of great importance for our daily moral concerns:

> ... the question of realism and nominalism [...] [has] branches [which] reach about our daily life. The question whether the *genus homo* has any existence except as individuals, is the question whether there is anything of any more dignity, worth, and importance than individual happiness, individual aspirations, and individual life. Whether men really have anything in common, so that the *community* is to be considered as an end in itself [....] is the most fundamental practical question in regard to every public institution ... (*EP* I, 105, 1871).

Moreover, he thought the nominalistic outlook of most modern philosophers was disastrous for the understanding of science. Nominalistic theories cannot explain that scientific theories are excellent tools for predicting future events. If we say, with Ockham, that all generalizations are subjective because they are based on the mind's capacity to form generalizations on the basis of perceived similarities, then our predictions miss any rational ground.

Peirce claimed to have proven the falsity of nominalism by a simple, by now famous, thought experiment (*CP* 5.93-101; 1903). In a Harvard class room he held up a stone, and asked his audience whether they could predict that it would fall if he were to drop it. Of course, everyone said he could. Peirce argued that this entails that there are real laws of nature. For if laws were merely generalizations of past happenings, there would be no ground for our *expectation* that the stone would fall to the ground. Hence, he drew the "irrefragable" conclusion that "*general principles are really operative in nature*" (*CP* 5.101). Without general principles, which are final causes (laws), prediction, induction and explanation would be impossible (*CP* 5.100-101; also Haack, 1992, 25-29). This view has the immediate implication that science must discover the true laws of nature, and therefore it must establish the kinds of things that are connected by those laws. In other words, science must point out natural classes.

9. EXAMPLES OF NATURAL CLASSES

We have seen that a natural classification is one that proceeds according to the purpose or quasi-purpose of the existence of the 'objects' classified. But what does the word 'object' depict in the above given description? Are the objects properties, processes, states, facts, events, or things? To answer this question, it seems advisable first to consider the examples Peirce gave of natural classes. We begin with the more obvious examples given in human experience.

9.1 Examples from the Realm of Human Experience: Social Classes, the Sciences, and Artificial Objects

The examples taken from the realm of human experience are usually easiest to classify, for in this domain it is often easy to discover by what purpose the objects of a class are determined. *Social classes* are examples of natural classes. Peirce mentions artists, practical men (business men), and scientists (*CP* 1.43; c. 1896). Each of these groups owes its identity to a specific purpose. One might extend the list to include Christians, Mathematicians, Jews, Muslims and Pagans. While Mill listed these as artificial classes, they are excellent illustrations of Peircean natural classes. On the other hand, Peirce would probably agree with Mill that 'Englishmen' constitute an artificial social class; for there is no specific identity or goal that is common and specific to the English.

The sciences provide a second category of examples of Peircean natural classes that are closely related to the realm of human action. Indeed, Peirce developed most of his ideas about natural classes while working out a classification scheme of the sciences. All science is divided into three major branches, each of which has a different purpose: Practical Science, Science of Review, and Science of Discovery or Research. Whereas Practical Science deals with investigations conducted for utilitarian purposes, the Science of Review aims at systematizing available knowledge. Science of Research is not defined in terms of available knowledge, but in terms of the concrete life of those whose "single animating purpose" it is to find out the truth for its own sake (*CP* 7.54; c.1902). Within each branch, every science is classified according to its specific purpose or object. The classifica-

tions are hierarchical; the more general the object, the higher is its place in the hierarchy.[23]

The *artificial objects* are the third category of examples from the domain of human culture. A natural classification of artificial objects is a classification according to the purpose for which they were made. Accordingly, it can be said that stoves are different from lamps because they serve a different aim. Often artificial objects may also be classified according to subsidiary purposes. Thus, bicycles may easily be classified into city bikes, mountain bikes, racing bikes, tracking bikes, etc., each according to its specific purpose. If we classify bicycles according to their purpose, the classification is natural; a classification according to color would be artificial.

To illustrate the precedence of form over matter in natural classifications, Peirce also gave an example from the domain of art: "... who would classify Rafael's paintings according to their predominant tinges instead of according to the nature of the composition, or the stages of Rafael's development?" (*NEM*, IV, 322; c.1906) Only the form or structure of the compositions "renders the composition of the entire classified object rationally intelligible," not their matter. Apparently, knowledge of this structure provides insight into the purposes of the painter.

Furthermore, there is an important similarity between classifications of works of art and classifications of chemical substances and biological classes; in all of these the final cause is displayed in some kind of structure.

9.2 The Chemical Elements

According to Peirce, the chemical elements differ in an important respect from all other natural classes: they are grouped not hierarchically, but periodically. Peirce insisted that when forms have developed from other forms, their genetic classification must be hierarchical. However, Mendeleef's classification of the chemical elements is definitely not hierarchical. "*It is a cross classification of an exact mathematical type*" (*MS* 421, 1893-5; italics mine). According to Peirce, this strongly indicates that, contrary to biological forms, the

chemical elements have not originated by a development of one from the other.[24] Indeed, it was Peirce's view that there are two different kinds of systematic relationships between different natural kinds. Whereas classes are normally grouped according to the Aristotelian hierarchical model, chemistry groups the elements periodically.

Dmitri Mendeleef had been the first person to arrange the elements according to their periodic similarities (1869). He found that if the elements are arranged approximately according to their increasing atomic weight, elements with similar physical and chemical properties occur at periodic intervals. His table proved to be a good guide to predicting chemical behavior, because it enabled us to determine what elements should be chemically similar to others. Not only do similar elements act alike, but their compounds may also act alike. For instance, NaCl has properties which are similar to those of both KCl and RbCl, because Na, K, and Rb are chemically alike.

Peirce, however, thought that the chemical elements owe their classification first and foremost to their valency. Indeed, natural classification is classification according to structure. But indecomposible chemical elements have no parts, and therefore no internal structure. Thus only their *external structure* must be taken into account. The *external structure* of an element was defined by Peirce as "the structure of its possible compounds" (*CP* 1.289; c.1908). In chemical elements, the basis of all external structure is valency:

> In classification generally, it may fairly be said to be established, if it ever was doubted, that Form, in the sense of structure, is of far higher significance than Material. Valency is the basis of all external structure; and where indecomposability precludes internal structure [...] Valency ought to be made the first consideration. (*MS* 292, p.34; 1906)

The view that elements are indecomposible has been refuted by 20th century physics. But in a way, the idea that elements do have an internal structure which determines their valency and behavior, only confirms the consistency of Peirce's view that (a) natural classification is

classification according to the final cause of the objects classified, and that (b) natural classification is classification according to structure. An external structure can hardly be a final cause of the objects classified, because it depends itself upon the existence of those objects. An attempt will be made to show that the internal structure can be such a final cause. First, however, it must be shown that internal structures can never be efficient causes.

That the internal structure cannot be an efficient cause appears from three facts: (a) whereas efficient causes are always concrete events or facts, internal structures are always *general*, for they are displayed in a multitude of events. Moreover, (b) because efficient causation is not directed toward an end in any way, it cannot explain that atomic structures are responsible for the atom's *tendency* to behave in a regular way. Finally (c), whereas efficient causes only induce one or more lines of mechanical causation at one singular moment, the atomic structure continually induces events to conform to a definite pattern.[25]

Because Peirce recognized only two types of causation — efficient causation and final causation — one is forced to conclude that inasmuch as the internal structure has some kind of causal influence, it must necessarily be teleological causation. Indeed, the internal structure has all the characteristics of final causation: (a) it is *general*, (b) it explains a *tendency* to behave in a regular way, and (c) it *continuously* induces processes of causation to conform to a definite pattern.

Thus, there is no reason for believing that Peirce would not have agreed with the contemporary insights of physics, according to which the external structure (or valency) of the chemical elements is determined by their internal structure. Therefore, according to our (20th century) interpretation of Peirce, it would be correct to say that the chemical elements are classified according to their internal or atomic structure.

Whereas the chemical elements are classified according to their atomic structure, the chemical *compounds* are classified according to their molecular structure. The classification of compounds is related to the fact that "... all samples of the same molecular structure react chemically in exactly the same way..." (*CP* 4.530; 1906). The molecular structure is represented by what chemists nowadays call the

structural formula, which is to be distinguished from the *molecular formula*, which merely gives the numbers of the different atoms. This explains that compounds with the same molecular formula do not necessarily belong to the same natural class: "who would for one instant liken ordinary alcohol to methyl ether (which has the same material composition) instead of with the alcoholates?" (NEM IV, 321-22). Though ordinary alcohol and methyl ether have the same molecular formula (C2H6O), they still have a different structural formula (respectively: CH3-CH2-OH and CH3-O-CH3). Ordinary alcohol does not belong to the same kind as methyl ether, because it has a different geometrical structure.

Similarly, analogous behavior of two compounds may indicate that the molecular structures are similar: "to take a simple example, chlorates KClO3, manganates KMnO3, bromates KBrO3, rutheniates KRuO3, iodates KIO3, behave chemically in strikingly analogous ways" (*CP* 1.223; 1902).[26] Similarity of behavior indicates that there is a similarity of *molecular structure*, and a certain degree of similarity of molecular structure is a good reason for believing that we are dealing with the same natural class.[27]

To summarize: the chemical elements and the chemical compounds are classified, respectively, according to their atomic and their molecular structures. Because Peirce defined natural classifications as those that were made according to the final cause to which the members of the class owe their existence, it may be concluded that he thought the final cause of the atom or the molecule to be expressed in their internal structure. Inasmuch as these structures are expressed in individual entities, they are neither universal nor particular. But *qua* structures, they are universal. According to Peirce, chemical structures are final causes, because (a) they are *general* (and therefore possibilities, not actualities), and because (b) they explain the *tendencies* to behave according to definite patterns.

Next we will see that for biological species the defining cause is also a chemical structure.

9.3 The Biological Species

Peirce was a chemist by training, who from his youth onwards had shown a serious interest in the classification of the chemical elements. It may be assumed that his interest in the problem of natural classes arose within that context. This idea is confirmed by the fact that he devoted many more pages to the chemical elements than, for example, to the biological species. This may also explain why Peirce tried to apply his findings about chemical kinds to the biological kinds.

Thus he sought the metaphysical essence (final cause) of biological species in their internal structure, which he identified with the chemical constitution of their protoplasm. He felt confident that future research would show that the chemical constitution of the protoplasm is "*the sole determining cause of the forms of all animals and plants*" (*CP* 1.262; italics mine). This leads us to believe that, if Peirce had known modern molecular biology, he would not have hesitated to consider the chemical structure of DNA as the metaphysical essence of biological species. DNA is precisely that part of the protoplasm that determines the essential morphological and functional characters of the biological species. Moreover, DNA is related to heredity. Thus, the cause of heredity is the chemical structure of DNA. And thus heredity must be related to final causality:

> Heredity [...] is not a force but a law, although, like other laws, it doubtless avails itself of forces. But it is essentially that the offspring shall have a *general* resemblance to the parent, not that this general resemblance happens to result from this or that blind and particular action. No doubt, there is some blind efficient causation, but it is not that which constitutes the heredity, but, on the contrary, the general resemblance. (*CP* 1.215; 1902)

Thus, whereas classification is always classification according to form, in biological species, the form is the expression of the internal structure of DNA. Because DNA is the final cause of the biological class, it may also be said that classification in biological species is classification

according to their final cause.

Peirce's approach was broadly Aristotelian inasmuch as natural classification always concerns the form of things (which is that by virtue of which things are what they are) and not their matter. This entails that Peirce borrowed Aristotle's idea that the form was identical to the intrinsic final cause. Therefore it was obvious that natural classification concerns the final causes of the things. From the natural sciences, Peirce had learned that the forms of chemical substances and biological species are the expression of a particular internal structure. He recognized that it was precisely this internal structure that was the final cause by virtue of which the members of the natural class exist.

To summarize: *whereas natural classes are not defined in terms of essential qualities, but in terms of a final cause (and therefore in terms of possible behavior), the final cause may yet be expressed in some empirical internal structure. The chemical substances, the biological species, and art objects are Peirce's main examples of such natural classes. In these cases, similarity of internal structure indicates that objects belong to the same natural class.*

10. WAS PEIRCE A PLURALIST REGARDING NATURAL CLASSES?

We started our investigation by giving a survey of the interpretations of Peircean natural kinds that were given by, respectively, Haack (1992), Hookway (1985), and Rosenthal (1994). One of the most important questions raised by them, was: how pluralistic is Peirce's conception of natural class?

Before tackling this question, it may be helpful to distinguish three meanings of pluralism, two of which I borrow from John Dupré. *Pluralism (1)*, as opposed to reductionism or eliminativism, refers to "the insistence on the equal reality and causal efficacy of objects both large and small" (Dupré, 1993, 7). This pluralism rejects *in principle* the reduction of macro-objects to subatomic particles. Eliminativism, in its most extreme form, would lead to the conclusion that there is only one natural class: the fundamental particles or processes of physics; microreductionism wants us to believe that causes at our normal,

common sense level of awareness, are not real. I will call the pluralism which rejects eliminativism and microreductionism *causal pluralism*.

Pluralism (2), as opposed to classical essentialism, is "the claim that there are many equally legitimate ways of dividing the world into kinds." Our classifications are partly determined by our interests or purposes, and partly by "the recalcitrance of nature." This pluralism rejects classical essentialism because it denies the idea that things possess essential properties (which are both necessary and sufficient for a thing to belong to a natural class), independently of any context of inquiry. But it maintains that our activity is constrained by events beyond our control. Questions like, To which natural kind does this object belong? are always relative to a context, that is to say, "such questions can be answered only in relation to some specification of the goal underlying the intent to classify the object" (Dupré, 1993, 5-6). For this type let us borrow Dupré's terms *promiscuous realism* or *radical ontological pluralism* (Dupré, 1993, 5-7,12,18).

However, 'pluralism' may also be the doctrine that we are entirely free to classify the world as we would like to. Accordingly, *pluralism (3)* may be defined as the claim that there are *infinitely* many equally legitimate ways of dividing the world into kinds; our classifications are not restricted by any 'recalcitrance of nature." Of course, the use of the prefix 'natural' to 'class' would become disputable, but the fact is that there are philosophers who speak of natural kinds in this way. I will call this type *anarchistic pluralism*. Whereas pluralism 1 is compatible with pluralism 2 and 3, pluralisms 2 and 3 are incompatible.

From our discussion in section 2, it appears that Haack considers Peirce to be a causal pluralist, Rosenthal sees him as a promiscuous radical ontological pluralist, while Hookway is bound to call him an anarchistic pluralist.

That Peirce was not a pluralist in the promiscuous sense (pluralism 2) and even less so in the anarchistic sense (pluralism 3), appears clearly from the following statement in which he explicitly denies the possibility of more than one system of natural classification: *"there are artificial classifications in profusion, but [there is] only one natural classification"* (*CP* 1.275, 1902; italics mine).

From our previous discussion it has appeared that natural classes are primarily determined by one and only one defining idea. This defining idea or D-character is the final cause to which the members owe their existence *as members of the class.* However, as a result of subsidiary purposes, there are different levels of natural classes: "there are several different categories of secondary and subordinate purpose. These categories of purpose must be categories of every system of natural classification" (*MS* 1343, p.16-17). Accordingly, "each class is distinguished by performing its part of the general purpose of the branch [the more general class], or carrying out the general idea in a special way" (*MS* 1344, p.15). Thus, a racing car belongs to the natural class of racing cars, as well as to the (more general) natural class of cars, and also to the (even more general) natural class of vehicles. Though natural classes may partially overlap with each other, and each object probably belongs to more than one natural class, there is but one natural system of classification. In this sense Peirce was a monist, not a pluralist.

To further clarify Peirce's view, it seems appropriate to consider Dupré's illustration of radical ontological pluralism:

> In relation to an account of the workings of a car, it is quite straightforwardly true that a particular constituent object should be classified, for example, as a piston. This classification correctly identifies the (sole) function of this constituent in the overall economy of the larger system of the car. But the unambiguousness of this identification is clearly relative to a particular context, the context defined by the overall function of the car. And it is quite possible for the career of the piston to exceed its tenure in the car and to continue as a hammer or a weapon. Since the world is not a machine, nature does not generally provide contexts that can serve to determine unambiguously the kinds to which objects belong, and such context must typically be provided instead by the goals of a particular investigation. (Dupré, 1993, 5-6)

I think that Peirce would have argued, against Dupré, that context may only be relevant in a very restricted sense; it determines the (hierarchical or periodical) level within our classification system at which we aim in our discussion. Thus context may determine that we rate a particular car to the natural class of racing cars instead of to the more general natural class of cars. But cars are cars, and pistons are pistons, even if they are used for different purposes. Remember that Peirce defined a natural class clearly as a class the members of which owe their *existence* to a common and peculiar final cause. Thus a piston is first and foremost a piston, independent of the way it is used. In this sense, Dupré's view is perhaps more radically functionalistic than Peirce's.

The idea that objects belong to unambiguously discoverable natural classes, is intimately connected with Peirce's specific essentialism: what makes an object belong to a particular natural class is that it be teleologically caused by the D-character. The D-character unambiguously determines to what natural class an object belongs, *independently of any context of inquiry* (in the sense that was meant by Dupré).

This interpretation is opposed to Rosenthal's, according to which the concept of a Peircean natural class is intimately related to a context of inquiry. Though she does not doubt that it is Peirce's view that within a certain commonly accepted context, investigation can "tend toward an ideal limit of convergence," she insists that it was not Peirce's view that there is also a convergence of contexts. There is not one ultimately correct context which clearly determines to what natural class an object belongs:

> When a community is operating within a common system of meanings on any one issue, then investigation can tend toward an ideal limit of convergence. However, when different segments of interpreters experience different facts because of different sets of meaning structures for cutting into the indefinitely rich continuity of possibilities of ordering, such convergence cannot occur. The criterion for adequately cutting is workability, but workability can be established only relative to some meaningful network by which experience is

> "caught." Thus there may be a pluralism of interpretations among varying groups of interpretations on any topic. For each group, identifiable by varying nets or perspectives for the catching of experience, is variously structuring some contours of a world. [...] [T]he essential pluralism is often hidden from view in the misplaced drive toward a common conclusion based on "the evidence." (Rosenthal, 1994, 17)

Against Rosenthal I would argue that Peirce's view that in the long run science will discover the final causes of things, entails that there is *one ultimate context* which is not determined by our purposes, but by the purposes (final causes) of the things themselves. Though there may be countless goals underlying our intent to classify, there is but one *natural* classification. It is not *our* purpose (final cause) that is at stake, but the final cause of the natural class itself (see section 5). And in that sense, Peirce was not a 'radical ontological pluralist.' When he writes that "truly natural classes may, and often do, merge into one another inextricably" (*CP* 1.209), he only meant to say that, though each object definitely belongs to a natural class, there are no sharp demarcation criteria by virtue of which it can always be unambiguously decided to which of two closely related classes an object belongs. Whenever closely related classes are not separated by sharp lines of demarcation, non-TDE (teleologically determined empirical) characters may help us in ascertaining to which of the two classes the object belongs: "unless we have some supplementary information we cannot tell which ones had one purpose and which the other" (*CP* 1.208). If Peirce's definition of a natural class as "a class of which all the members owe their existence to a common final cause" (*CP* 1.204) is taken seriously, one cannot but conclude that even the members of apparently fuzzy classes belong to specific natural classes, regardless of the difficulty we experience in our attempt at classification.

If natural classes are not even partly determined by our interests and conventions, then Hookway's position that "[g]enerality is real, but dividing things into classes reflects our interests and conventional decisions" must also be rejected (Hookway, 1985, 251). Hookway

concurs with Peirce when he writes that natural classes are real, but he fails to see the implication for natural classes. Natural classes are real, because they *are* generals. Though dividing things into classes may reflect our interests, *natural* classes do not. Hookway's interpretation may be due to his mistakenly conceiving natural classes as concrete, *existing* things. But such conception is the result of a category mistake.

But, whereas Peirce was neither a 'radical ontological pluralist' nor an 'anarchistic pluralist,' he most certainly defended a *causal pluralism*. There are many different levels of natural classes (physical entities, chemical entities, biological entities, sociological entities, artifacts, etc.), and therefore also many different levels of causation. *Each class is characterized by a distinctive final cause, and the objects belonging to a natural class do so by virtue of their ability to exert a type of real causal influence*. Thus, it is the task of science to determine exactly what natural classes there are.

The idea that Peirce was a causal pluralist agrees with Haack's interpretation of Peircean natural kinds. As we have seen, Haack correctly pointed out that Peircean natural kinds are "the kinds of things in the world that really do behave in a lawlike way."[28] If so, examples of natural classes are horses, men, and stones,[29] which are all macroscopic objects. She therefore clearly acknowledged that Peirce thoroughly rejected any kind of microreductionism. Not only the fundamental processes of physics can have a real causal influence, but so can men, horses, and all kind of other macro-objects.

But Haack's paper was not intended to give a detailed account of Peircean natural classes (neither were the relevant parts in Rosenthal's and Hookway's books). Hence we should not be surprised that her picture is in some ways incomplete. For instance, she fails to provide a precise enough definition and precise demarcation criteria which might help us to distinguish natural classes from artificial ones. Moreover, by not considering Peirce's theory of natural classes within the context of his theory of final causation, she was not able to explain why the world of physics is not more real than our common sense world, or why there is no ontological conflict between the objects of scientific inquiry and the objects of other endeavors. Scientific ob-

jects belong to natural classes, but so do artificial objects, because in both cases the existence of these objects is determined by a final cause which is common and specific to the members of the class. Finally, she also fails to give a clear insight into the problem of the relationship between natural classes and causation.

12. CONCLUSION: NATURAL CLASSES AND CAUSATION.

The problem of natural kinds is important because it is inextricably linked to several philosophical notions, such as induction, universals, scientific realism, explanation, causation, and natural law. The main concern of this paper has been the relationship between natural classes, causation and natural laws. Natural classes are often seen as the kinds of things that behave in a lawlike way; objects belonging to the same natural class are considered to play the same causal role in nature. This somehow involves the notion that lawful causal relations presuppose that there are natural classes.

In this paper, it was established that Peirce's mature discussion of natural classes was intimately related to his theory of causation. According to this theory, while each event is part of a continuous chain of events, each chain of events is characterized by some kind of tendency. Thus, each act of causation has an efficient and a final component. The efficient aspect of causation is that each event is caused by a previous event (the efficient cause); the teleological aspect is that each event is part of a causal chain with a definite tendency. Although this is an original and provocative theory, Peirce unfortunately still clung to the expression 'final cause.' This expression is misleading, because what Peirce meant by a 'final cause' was altogether different from what we nowadays call 'a cause.'

Peirce's originality in respect of natural classes concerns at least two insights: first, he made clear that all classification, be it natural or artificial, must be related to some purpose. Secondly, *natural* classifications do not primarily involve our purposes, but the final causes of the classified things themselves.

Accordingly, Peirce's view may be summarized as follows: Things belong to the same natural class on account of a metaphysical essence

and a number of class characters. The metaphysical essence is a general principle by virtue of which the members of the class have a tendency to behave in a specific way; this is what Peirce meant by final cause. This finality may be expressed in some sort of microstructure. The class characters which by themselves are neither necessary nor sufficient conditions for membership of a class, are nevertheless concomitant. In the case of a chair, the metaphysical essence is the purpose for which chairs are made, while its having chair-legs is a class character. The fuzziness of boundary lines between natural classes is due to the fuzziness of the class characters. Natural classes, though very real, are not existing entities; their reality is of the nature of possibility, not of actuality. The primary instances of natural classes are the objects of scientific taxonomy, such as elementary particles in physics, gold in chemistry, and species in biology, but also artificial objects and social classes.

In respect of the contemporary discussion, Peirce's view involves a rejection of microreductionism and eliminativism as viable theories of natural classes; Peirce's theory, which we have labelled a *causal pluralism* (because it insists on the equal reality and causal efficacy of both micro- and macro-objects), does not reduce our common sense, daily experience in favor of some abstract, physical principles. Though the scientific method may yield knowledge of natural classes, there are many obvious examples that are derived from common, human experience.

By denying that final causes are static, unchangeable entities, Peirce avoided the problems attached to classical essentialism. On the other hand, by eliminating arbitrariness, Peirce also avoided pluralistic anarchism. Though Peircean natural classes only come into being as a result of the abstractive and selective activities of the people who classify, they reflect objectively real general principles. Thus, there is not the slightest sense in which they are arbitrary: "there are artificial classifications in profusion, but [there is] only one natural classification" (*CP* 1.275; 1902).

Catholic University Nijmegen

NOTES

1. The investigations for this article were supported by the Foundation for Research in the Field of Philosophy and Theology which is subsidized by the Netherlands Organisation for Scientific Research (NWO). I thank Guy Debrock, Jaap van Brakel and Peter Kroes for their critical comments on earlier drafts, and William Hornix for some useful comments on the section on chemical substances. I thank Nathan Houser and André De Tienne (Peirce Edition Project, Indianapolis), and Kenneth Ketner (Institute for Studies in Pragmaticism, Lubbock) for helping me in collecting the relevant manuscripts.

2. All references of the type MS xx refer to Peirce's manuscripts as listed in Richard Robin's *Annotated Catalogue of the Papers of Charles S. Peirce,* Amherst, 1967. References of the type *CP* x.xx refer to the volume and paragraph number of the *Collected Papers of Charles S. Peirce,* 8 vols., Harvard University Press, Cambridge Mass., Vol. 1-6, 1931-5, edited by Ch. Hartshorne and P. Weiss; Vol. 7-8 edited by A. Burks, 1958. References of the type NEM x,yy refer to volume and page numbers of *The New Elements of Mathematics by Charles S. Peirce,* edited by C. Eisele, 4 volumes in 5 books, The Hague, Mouton, 1976. References of the type *EP* I, xx refer to the page number of the first volume of *The Essential Peirce: Selected Philosophical Writings* (1867-1893), eds. N. Houser and C. Kloesel, Bloomington, Indiana University Press, 1992.

3. Hacking, 1991.

4. Only this can explain that Haack, in an otherwise brilliant paper on Peirce's "Scholastic Realism," could write about the relationship between natural classes and final causation: "I am unable to judge whether Peirce's suggested characterization could be made acceptable" (Haack, 1992, 50, note 45). Similarly, Beverly Kent, in her extensive book on Peirce's "Logic and the Classification of the Sciences," ignores the importance of final causation in conjunction with natural classifications because "Peirce was often obscure, if not actually mystical, in some of his writings on final causation within the context of natural classification" (Kent, 1987, 229, note 11). A notable exception of someone who does recognize the importance of final causation for natural classifications is Helmut Pape (1989, 1993). Pape's discussion, however, concerns primarily Peirce's idea of a natural classification of the sciences, rather than his idea of natural classes.

5. Hulswit, 1996.

6. In Kripke's own words: "Given that gold *does* have the atomic number 79, could something be gold without having the atomic number 79? ... consider a possible world ... in which, let us say, fool's gold or iron pyrites was actually found in the areas which actually contain gold now ... Would we say ... that in that situation gold would not even have been an element (because pyrites is not an element)? ... One should *not* say that [this substance] would still be gold in this possible world though gold would then lack the atomic number 79. It would be some other stuff. ... It [is] necessary and not contingent that gold be an element with atomic number 79" (Kripke, 1980, 123).

7. Van Brakel, 1992, 243-4.

8. Successively: Haack, 1993a, 134; Haack 1992, 29 and Haack 1992, 25.

9. See Hacking, 1991, 118.

10. Note that, for the young Peirce, the rejection of strict uniformities does not entail the rejection of determinism. It was only from 1880 on that Peirce sets out to challenge determinism.

11. For example in Peirce's earliest text about natural kinds, which we have discussed in section 3.2 *(W* 1, 416; 1866); also in his *MS* 421; c. 1893-5.

12. Peirce would not make the distinction between kind and class until 1908.

13. "An *important* character is obviously one upon which others depend, that is, one the inclusion of which in a definition renders true general propositions concerning the object defined possible; and the more such propositions a character renders possible, the more important it is" (*W* 2, 443; 1867).

14. References to manuscripts that begin with 00 are from Kenneth Ketner's IP (Institute for Studies in Pragmaticism) numbering system.

15. The insight that Peirce borrowed his idea that generals are possibles from Duns Scotus, I owe to Mauer (1983, 8).

16. I avoid the expression 'PRE-character' simply because Peirce no longer refers to them beyond the year 1902. This will be further explained in section 5.

17. For Peirce's Century Dictionary Definition of 'essence,' see the appendix to this paper (or *W* 5, 417; 1886).

18. In 1902 Peirce applied for a grant from the Carnegie Apllication to complete and publish his studies in philosophy. His request was not honored.

19. For an explanation of Peirce's conception of teleology, see Hulswit, 1996. For an explanation of his "developmental teleology," see 195-8.

20. The same observation has been made by Hilary Putnam: "it sounds strange to be told that a human being is not identical with the aggregation of the molecules in his body. Yet on a moment's reflection each of us is aware that he was not *that* aggregate of molecules a day ago. Seven years ago, precious few of those molecules were in my body. If after my death that exact set of molecules is assembled and placed in a chemical flask, it will be the same aggregation of molecules, but it won't be *me*" (Putnam, 1995, 235).

21. For this evolution from Peirce's early nominalist sympathies toward his mature commitment to scholastic realism, see Fisch, 1986.

22. Though Peirce does not speak of essential qualities in his 1866 paper, he does speak about "properties which are implied" in the definition of the natural class (*W* 1, 418).

23. For explanations of Peirce's Natural Classifications of the Sciences, see Kent (1987) and Pape (1989, 1993). Pape explicitly deals with the relationship between final causation and natural classifications.

24. Peirce has a second argument for his idea that chemical elements were not subject to evolution: "The irregularities of biological classification are the traces of the geological vicissitudes through which the earth's surface has passed. There is no trace of anything analogous to this in the chemical classification" (*MS* 421).

25. For a detailed account of the differences between efficient and final causation, see Hulswit, 1996, esp. 188-191.

26. Manganates are in fact K2MnO4, and rutheniates K2RuO4.

27. The question regarding the criteria of 'sufficient similarity' is empirical in nature; it has to be answered by chemistry. In contemporary chemistry, analogous behavior points to analogous molecular structure even when there is no similarity in molecular formulas. In those cases, the chemist will try to rewrite the formulas in an analogous form. For example, the molecular formulas CH4O (methanol) and C2H6O (ethanol) are rewritten as the structure formulas CH3OH and C2H5OH.

28. This also agrees with Hacking's interpretation. According to Hacking, that which makes something a Peirce-kind is "its role in a systematic interconnected web of laws of nature" (Hacking, 1990, 120-21). Hacking's

formulation contains both a mistake and an important insight. His description is misleading inasmuch as his expression "laws of nature" suggests that Peirce's notion of law is restricted to what we nowadays consider to be the (fundamental) laws of nature. Haack's reference to habitlike behavior is much more appropriate. However, Hacking's description contains an important insight which is lacking in Haack's description. A Peirce-kind is not only characterized by the sum of its habits, but also, and even more so, by a *systematic connection* of habits. This is provided by the final cause to which the members of the class owe their existence.

29. There are no final causes or laws that are specific to stones. The law of gravity is a final cause which makes all things of a certain density approach the centre of the earth, not just stones. Peirce's Harvard experiment was not so much about what natural kinds there are; its purpose was only to prove that there are "general principles operating in nature."

REFERENCES

Bigelow, J., B. Ellis and C. Lierse

1992 "The World as One of a Kind: Natural Necessity and Laws of Nature," *The British Journal for the Philosophy of Science,* 43: 371-388.

Boyd, R., Ph. Gasper, and J.D. Trout (eds.)

1991 *The Philosophy of Science,* Cambridge, Mass., and London: MIT Press.

Fisch, M.

1986 "Peirce's Progress from Nominalism toward Realism," in his *Peirce, Semeiotic, and Pragmatism, Bloomington:* Indiana University Press, 184-200.

Dupré, J.

1993 *The Disorder of Things. Metaphysical Foundations of The Disunity of Science,* Cambridge, Mass. and London: Harvard University Press.

Haack, S.

1992 "Extreme Scholastic Realism:" Its relevance for Philosophy of Science Today," *Transactions of the Charles S. Peirce Society: A Quarterly*

Journal in American Philosophy, 28: 19-50.

1993a *Evidence and Inquiry. Towards Reconstruction in Epistemology*, Oxford and Cambridge, Mass.: Blackwell Publishers.

1993b "Pragmatism," in: J. Dancy and E. Sosa (eds.), *A Companion to Epistemology*, Blackwell Companions to Philosophy, Oxford and Cambridge Mass., 351-357.

Hacking, I.

1991 "A Tradition of Natural Kinds," *Philosophical Studies*, 61: 109-126, 149-154.

Hookway, Ch.

1985 *Peirce*, London, Boston, Melbourne and Henley: Routledge & Kegan Paul.

Hull, D.

1978 "A Matter of Individuality," *Philosophy of Science*, 45: 335-360.

Hulswit, M.

1996 "Teleology: A Peircean Critique of Ernst Mayr's Theory," *Transactions of the Charles S. Peirce Society: A Quarterly Journal in American Philosophy*, 32: 182-214.

Johnson, D.M.

1990 "Can Abstractions be Causes?," *Biology and Philosophy*, 5: 63-77.

Kent, B.

1987 *Charles S. Peirce. Logic and the Classification of the Sciences*, Kingston and Montreal: McGill-Queen's University Press.

Kripke, S.

1980 *Naming and Necessity*, Oxford: Blackwell.

Levinson, J.

1991 "Attribute," in H. Burkhardt and B. Smith (eds.), *Handbook of Metaphysics and Ontology*, München: Philosophia, 1: 65-70.

Mauer, A.

1983 "C.S. Peirce and Duns Scotus," *Krisis*, 1: 6-9.

Mill, J.S.

1874 *A System of Logic*, New York: Harper & Brother Publishers.

Pape, H.

1989 *Erfahrung und Wirklichkeit als Zeichenprozess. Charles S. Peirces Entwurf einer Spekulativen Grammatik des Seins*, Frankfurt am Main:

Suhrkamp.

1993 "Final Causality in Peirce's Semiotics and his Classification of the Sciences," in *Transactions of the Charles S. Peirce Society: A Quarterly Journal in American Philosophy*, 29: 581-607.

Putnam, H.

1995 "Why There Isn't a Ready Made World," in his *Realism and Reason: Philosophical Papers Volume 3*, (1987), 205-28, Cambridge Mass.: Cambridge University Press; reprint in: P.K. Moser and J.D. Trout (eds.) (1995), *Contemporary Materialism. A Reader*, London and New York: Routledge, 225-244.

Quine, W.V.

1969 "Natural kinds," in his *Ontological Relativity and Other Essays*, New York: Columbia University Press, 114-138.

Rosenthal, S.

1994 *Charles Peirce's Pragmatic Pluralism*, New York: State University of New York Press.

Sober, E.

1995 "Natural Kinds," in J. Kim and E. Sosa (eds.), *A Companion to Metaphysics*, Blackwell Companions to Philosophy, Oxford and Cambridge, Mass.: Blackwell Companions to Philosophy, 345-346.

Van Brakel, J.

1992 "Natural Kinds and Manifest Forms of Life," *Dialectica*, 46: 243-261.